Perceptual and Motor Skills, 1993, 76, 168-170. © Perceptual and Motor Skills 1993

SHIFTS IN THE PLUTCHIK EMOTION PROFILE INDICES FOLLOWING THREE WEEKLY TREATMENTS WITH PULSED VS CONTINUOUS CEREBRAL MAGNETIC FIELDS [1]

CORRI GILLIS AND M. A. PERSINGER

Laurentian University

Summary.—Compared to baseline measures, the emotional profile indices of normal volunteers who received 3 weekly exposures to 20 min. of bilateral burst-firing magnetic fields along the temporal plane displayed increased aggression and decreased trust relative to those exposed to pulsed (1 sec. every 4 sec.) fields or to control conditions. The effect size was equivalent to an *eta* of 0.70. There were no shifts in Holtzman Inkblot Projection Scores. These results suggest that brief cerebral exposures to weak magnetic fields that simulate the burst-firing of amygdaloid cells may affect specific limbic emotions.

We have assumed that phenomenological (experiential) themes at any given time are a function of those portions of the brain that are most metabolically active as a consequence of exogenous or endogenous stimuli. The results of multiple PET (positron emission topography) studies have shown that specific cognitive tasks preferentially activate specific brain regions (1). Conversely, direct stimulation of specific brain regions should also evoke structure-specific experiences. We (5, 8) have shown that a single 20-min. exposure to different wave forms of weak magnetic fields (intensities much less than a hairdryer) evoke expected temporal lobe-related experiences in semisensory deprived settings.

Whereas a single 20-min. episode of only right temporal lobe stimulation by a burst-firing pattern for 1 sec. every 4 sec. evoked fear-like responses in women (8), a single bilateral presentation has been associated with positive affect (9). Analysis of phenomenological experiences that were reported subsequent to a *single* exposure to either intermittent or continuous bilateral stimulation by this field pattern for 20 min. indicated a significant increase in "emotional experiences," particularly irritability, for the latter (5). We reasoned that repeated exposure should successively sensitize amygdaloid neurons and enhance more indirect indices of irritability. On the bases of clinical experience, effect size should exceed an *eta* of 0.50 (25% of variance) to have any practical implication.

To test this hypothesis, 3 women and 9 men (18 to 22 years of age) were randomly assigned to one of three conditions (1 woman/group). For the baseline condition, each subject sat in a comfortable chair in semidarkness within an acoustic chamber and was asked to wear a helmet. After 20 min.

[1]Please send correspondence to Dr. M. A. Persinger, Behavioral Neuroscience Laboratory, Department of Psychology, Laurentian University, Sudbury, Ontario P3E 2C6.

each subject was asked to describe the first 15 cards of the Holtzman Inkblot (4) series (Form A) and then to complete Plutchik's Emotions Profile Index (7). Five [form definitiveness (FD), movement (M), human (H), anxiety (Ax), and hostility (Hs)] of the standardized Holtzman variables and the 8 circumplex emotions scores of Plutchik served as baseline data. There were no statistically significant ($p > .05$) differences between groups for baseline measures.

On the same night for each of the subsequent three weeks, each subject received the same treatment; the female experimenter was naive with respect to the expected effects. Four subjects received 20 min. of continuous 50-mG (milligauss) magnetic fields that simulate the burst-firing of human amygdaloid neurons while another 4 received this pattern for 1 sec. every 4 sec. during the 20-min. period; both field treatments were applied through the temporal plane by small solenoids. The other 4 subjects served as controls. The complex field pattern was generated by computer; the procedure has been described previously (5, 8, 9).

At the end of each session the same series of inkblots and the Emotion Profile Indices were completed again by each subject. All responses were tape-recorded and transcribed. The means of each of the 5 Holtzman scores and each of the 8 Emotion Profile Index raw scores (transformed scores for the group were within the normal range) for each of the three sessions were determined for each subject. These values were then subtracted from the baseline values; potential group effects were evaluated by analyses of variance. All analyses involved SPSS^X software on a Vax 4000 computer.

There were no statistically significant group effects for any of the Holtzman indicators. Because preliminary repeated-measure analyses (treatment by session) suggested statistically significant main effects but marginal treatment by session interactions, the mean scores for the three treatment nights for each measure were calculated and compared to baseline values. Statistically significant changes occurred for the timidity and aggression scales of the Emotion Profile Index. For the control, continuous presentation, and pulsed presentation groups, the means and standard deviations for the change in raw scores were +3.3 (2.3), +7.4 (3.5), and −0.1 (1.9) on aggression ($F_{1,10} = 7.88$, $p = .01$; $eta = 0.79$). There was a comparable but inverse change in timidity (which occupies the opposite position on the circumplex profile).

[For future comparisons, the means and standard deviations for baseline measures were 6 (3) and 16 (5) on aggression and timidity, respectively.] *Post hoc* analyses indicated that the major source of the effect was between the continuous and pulsed field presentations. The decrease (*M* and *SD*, respectively) in trustfulness (−4.5, 4.3) in the continuous-field group compared to the pulsed (1.1, 2.1) and control (−1.9, 1.4) groups approached significance ($F_{1,10} = 3.76$, $.05 < p < .10$; $eta = 0.68$).

These results suggest that transtemporal stimulation by weak magnetic fields [whose strengths are similar to those measured near personal computers (10 to 30 mG, 60-Hz sine wave) and much less than those generated by hairdryers (200 to 2000 mG; 60-Hz sine wave)] only once per week can enhance aggression and distrustfulness. The emergence of this factor has been reported by Bisson and Whissell (2). The opposite effect, which is commensurate with previous studies (5, 8), was shown with a burst pattern that enhances positive affect. There was, however, no strong evidence that electromagnetic stimulation altered the perception of ambiguous (inkblot) stimuli.

The duration of these effects had not been addressed previously; this study suggests some measurable effect may be maintained for at least one week. Both the effect size and its consistency indicate that this technique may be an alternative method for mapping the phenomenological correlates of brain stimulation. As the characteristics of the exogenous magnetic field converge with the endogenous neuromagnetic properties, weaker and weaker field strengths should be required to evoke long-term changes in cognitive networks given the intrinsic properties of structural resonance and energy transfer.

Although the field strengths exceed those associated with moderate to extreme geomagnetic activity by a factor of between 10 to 100, the specific effect upon aggression may be relevant. Correlative symptoms, such as cardiac aperiodicity, escalations of antisocial behaviors, and agitation among psychiatric patients, are strongly associated with measured or suspected paroxysmal activity within the amygdala (3). If the present results are generalizable, then electromagnetic stimulation of this limbic structure might alter the emotional dimensions of linguistic experience rather than the perception of ambiguous stimuli directly. That *specific patterns* of magnetic field-induced currents could affect thinking at specific affective nodes rather than the cognitive foci within the propositional structure during discourse planning (6) is a possibility that should be pursued.

REFERENCES

1. Andreasen, N. C. (1988) Brain imaging: applications in psychiatry. *Science*, 239, 1381-1388.
2. Bisson, C., & Whissell, C. (1989) Will premenstrual syndrome produce a Ms. Hyde? Evidence from daily administrations of the Emotions Profile Index. *Perceptual and Motor Skills*, 65, 179-184.
3. Bureau, Y. R. J., & Persinger, M. A. (1992) Geomagnetic activity and enhanced mortality in rats with acute (epileptic) limbic lability. *International Journal of Biometeorology*, 36, 226-232.
4. Holtzman, W. H. (1961) *Guide to administration and scoring: Holtzman Inkblot Technique.* New York: Psychological Corp.
5. Persinger, M. A., Koren, S. A., Makarec, K., Richards, P., & Youlton, S. (1991) Differential effects of wave form and the subject's possible temporal lobe signs upon experiences during cerebral exposure to weak intensity magnetic fields. *Journal of Bioelectricity*, 10, 141-184.
6. Persinger, M. A., & Makarec, K. (1992) Interactions between temporal lobe signs, imaginings, beliefs and gender: their effect upon logical inference. *Imagination, Cognition and Personality*, 11, 149-166.
7. Plutchik, R., & Kellerman, H. (1974) *Emotion Profile Index, manual.* Los Angeles, CA: Western Psychological Press.
8. Richards, P., Koren, S., & Persinger, M. A. (1992) Experimental stimulation by burst-firing weak magnetic fields over the right temporal lobe may facilitate apprehension in women. *Perceptual and Motor Skills*, 75, 667-670.
9. Richards, P. M., Persinger, M. A., & Koren, S. A. (in press) Modification of activation and evaluation properties of narratives by weak complex field patterns that simulate limbic burst firing. *International Journal of Neuroscience.*

Accepted January 4, 1992.